Levee Integrity and Subsidence:
Tied at the Hip for the Future of the Delta

Chris Enright

DWR

October 4, 2004


Jones Tract
September 4, 2004

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- Major failure recovery, if attempted, will be long and costly.
- The Delta ecosystem will change.
- Project export water quality is at risk.
- Subsidence is a primary risk and cost driver.

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- Saying the obvious about Delta levees and subsidence

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- What we learned from Jones Tract

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- Needed science
- *Levee integrity and subsidence are tied at the hip*

What we learned

Historical perspective:

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- 43 levee breaks on 36 islands in the Delta since 1971
- Studies show impending peril to Delta: 1-in-4 chance of multiple levee failures from earthquake in the next thirty years.

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- *Some* levees are essential to the integrity of the water projects.
- Private reclamation districts are responsible for maintenance of most Delta levees.
- RD's lack of resources requires intervention.
- Private levee problem became a statewide water resource catastrophe.
- Could have been much worse.

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- Levees “aren’t sexy enough,” -- “someone else’s problem until they break.”
- CALFED: levees not in draft Delta improvements plan
- Implicit: Levee constituency is difficult to forge

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- What is reclamation district incentive?
- Is this disaster relief or subsidy?

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- Delta wide, another Folsom Reservoir is added every twenty years.

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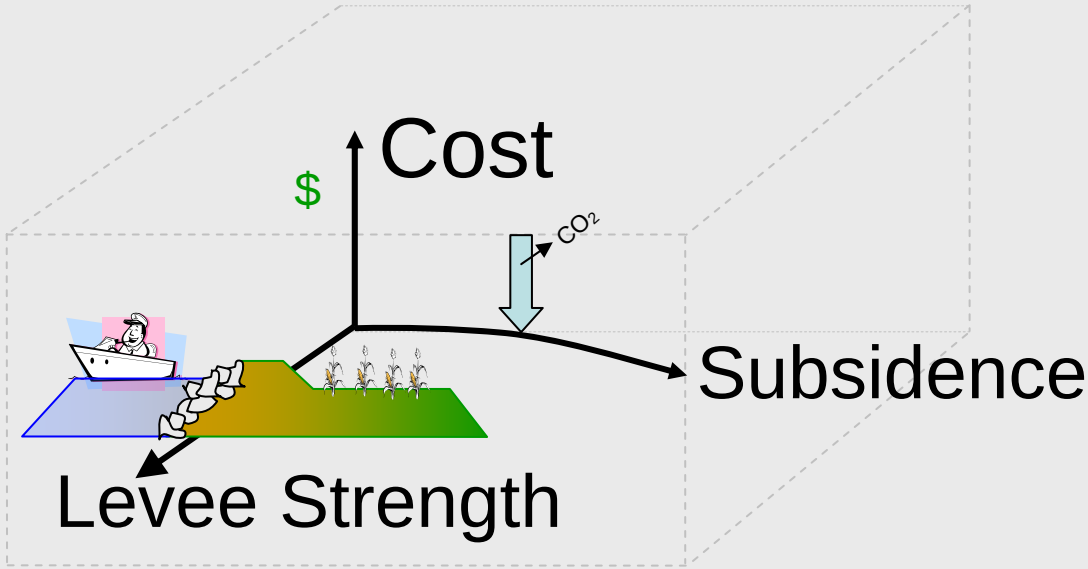
- *agriculture on peat soils causes subsidence and creates the need for ever larger and more expensive levees to maintain the same level of protection*.

Subsidence increases levee cost



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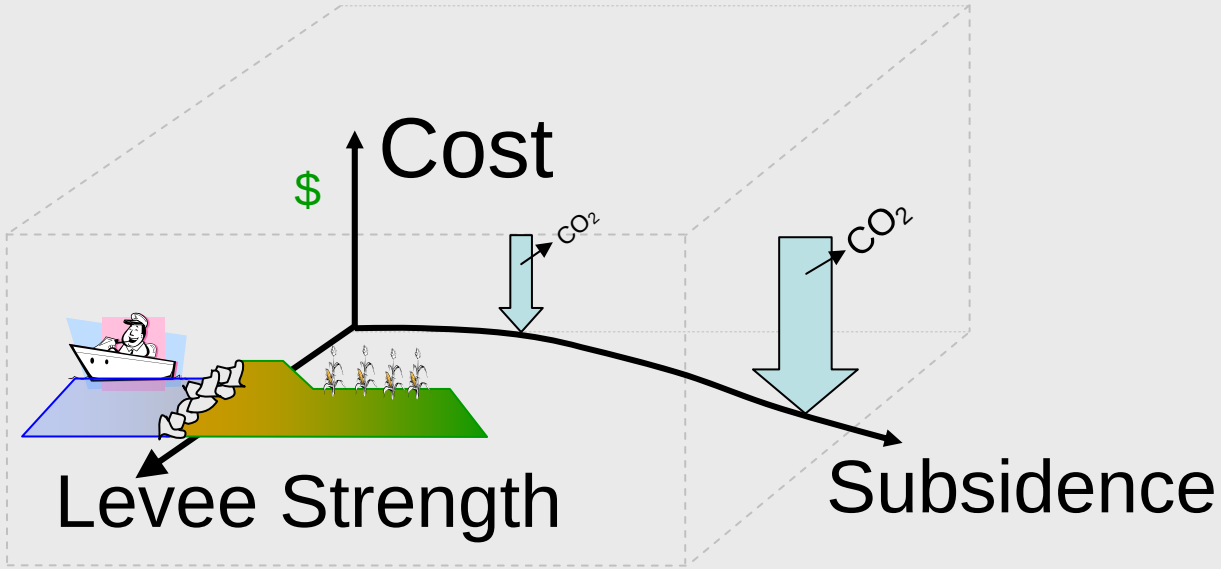

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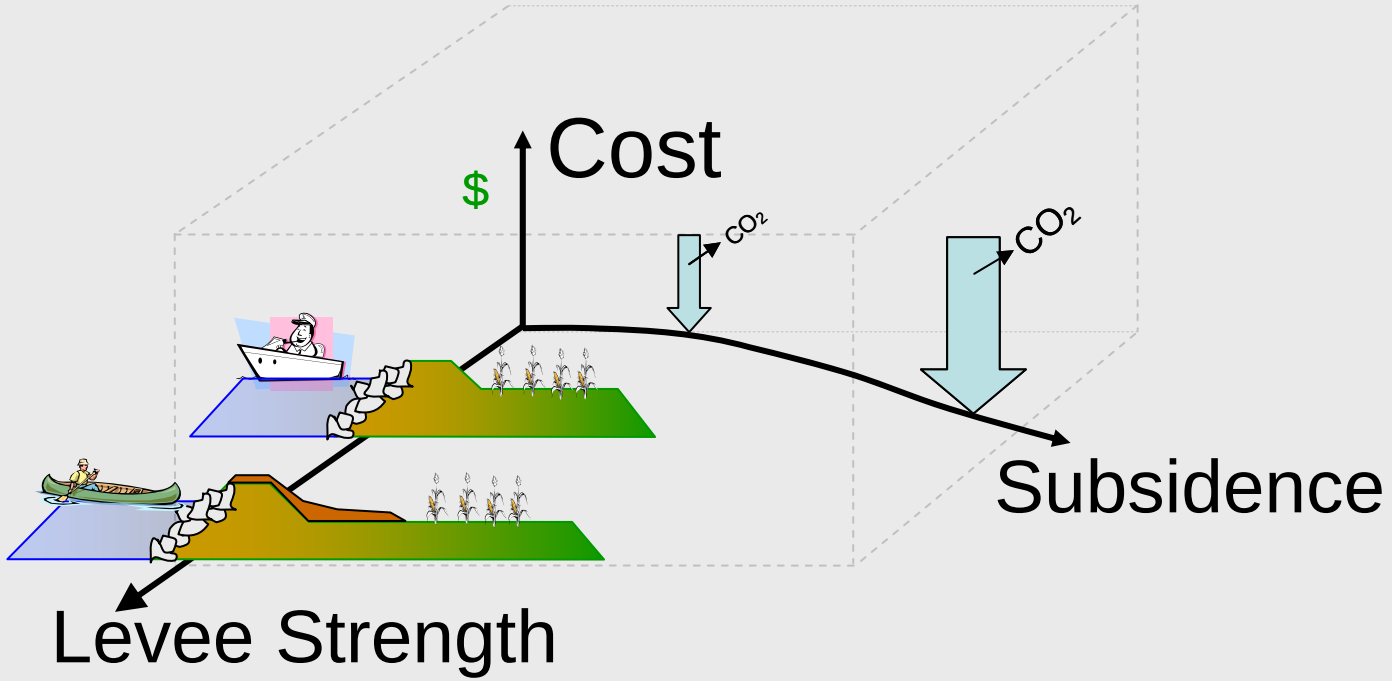

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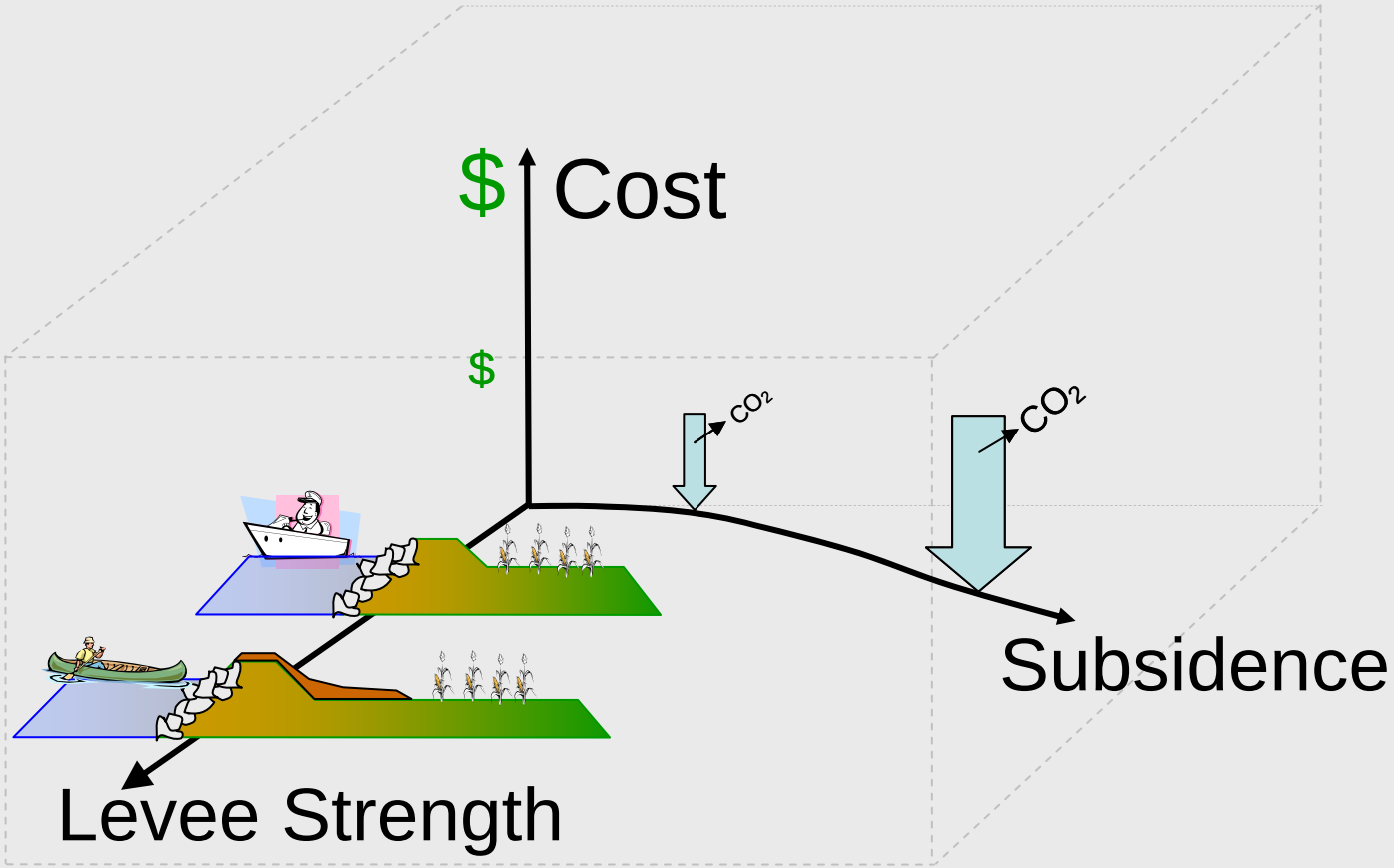

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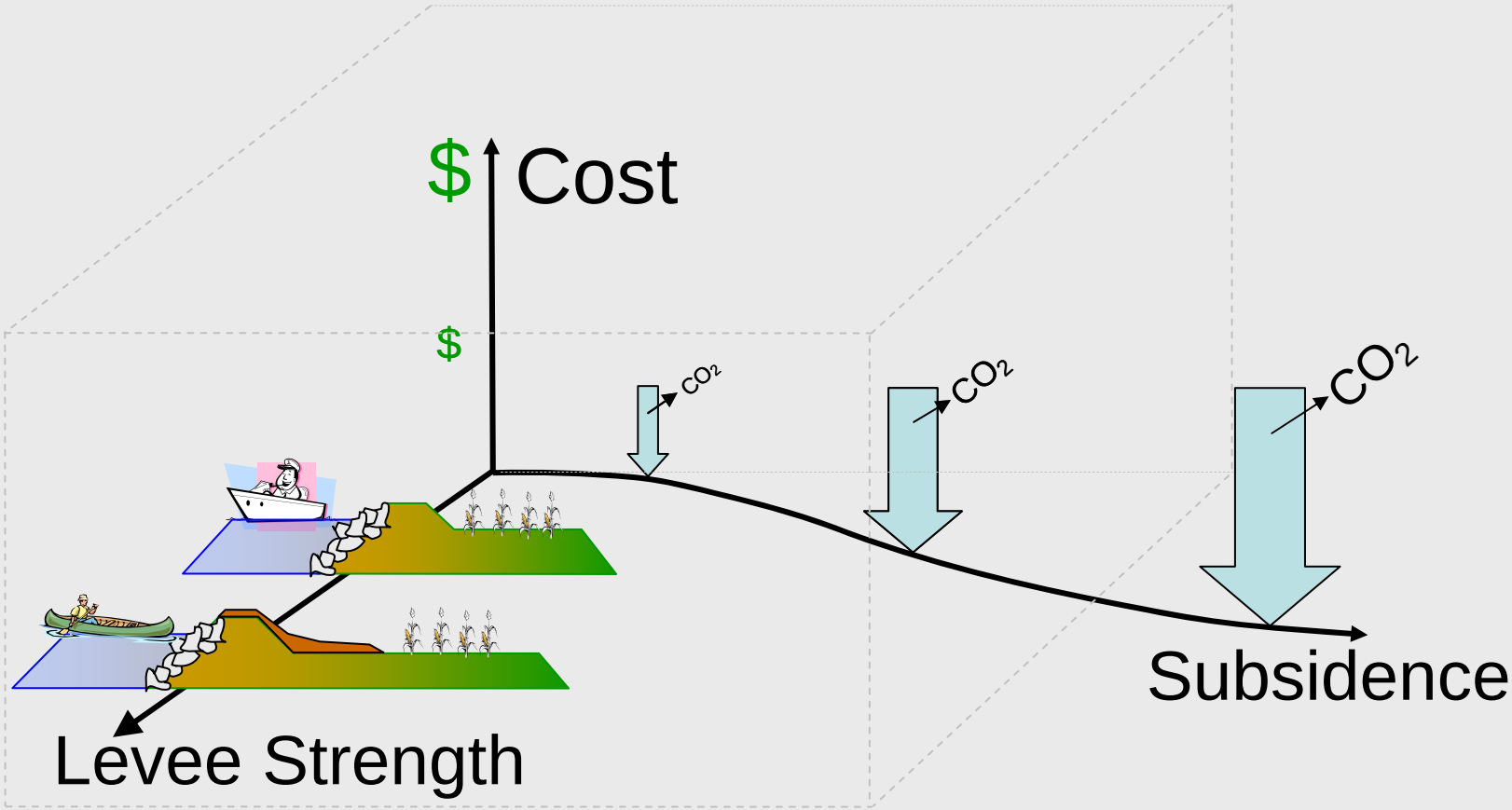

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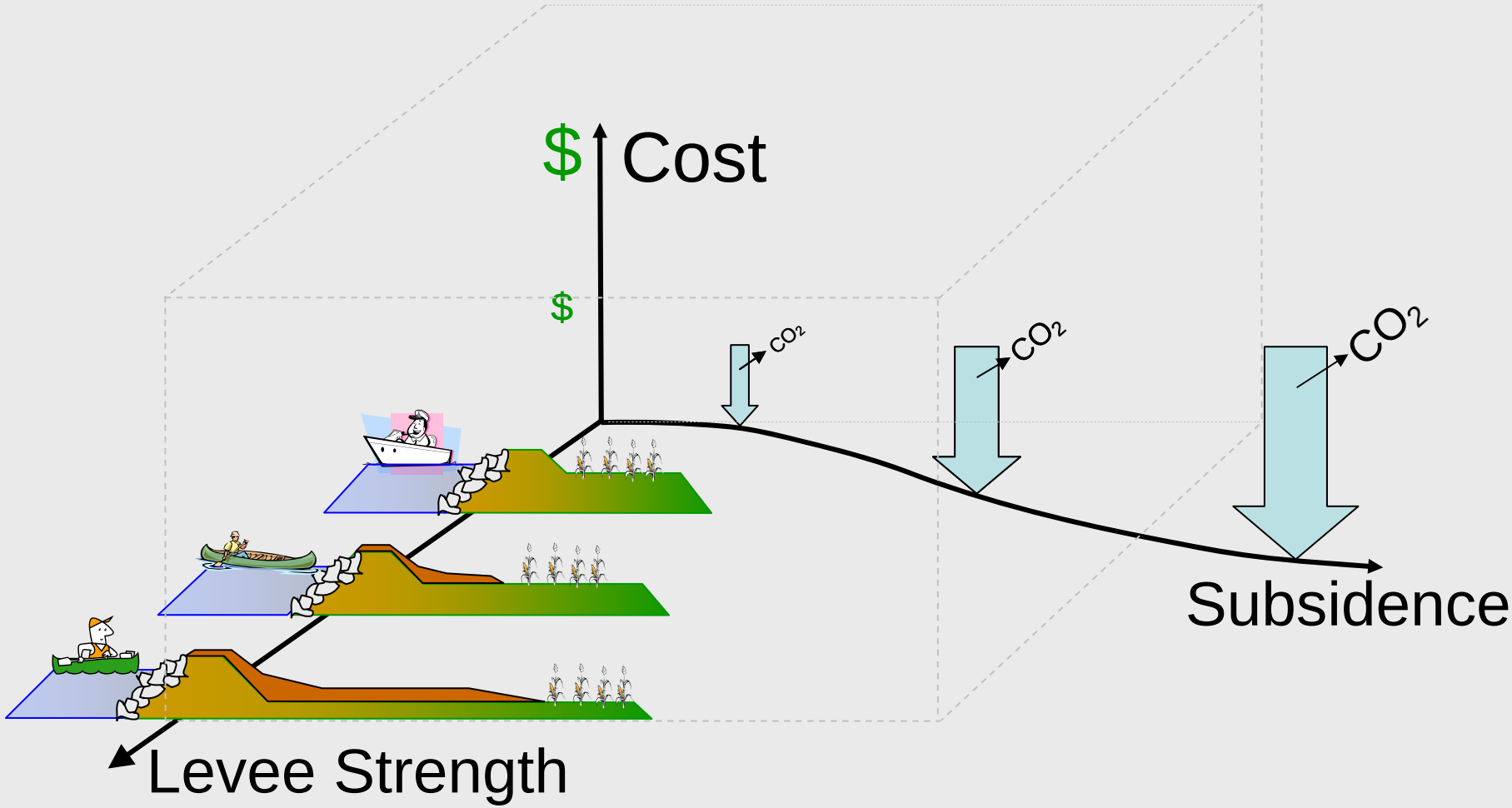

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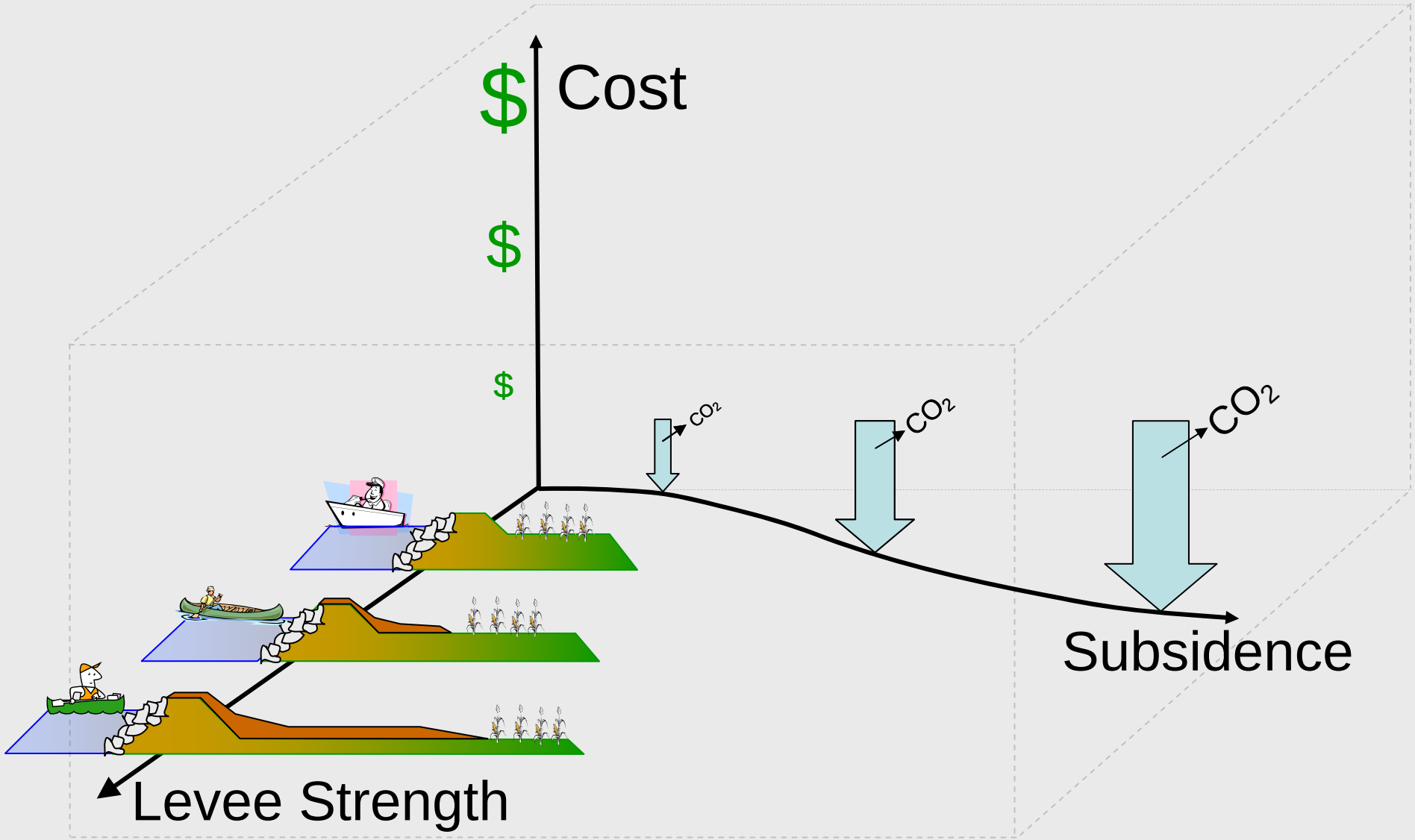

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- Subsidence is really an “impact” of land use.
- Beneficiaries pay for cost of subsidence.

Levee Integrity depends on:

- Material properties (% organic/mineral)
- Foundation properties (weight baring capacity)
- Levee material unit weight
- Levee geometry
- Vegetation
- Wind fetch/wave attack
- Seismic loading
- Cyclic tidal loading

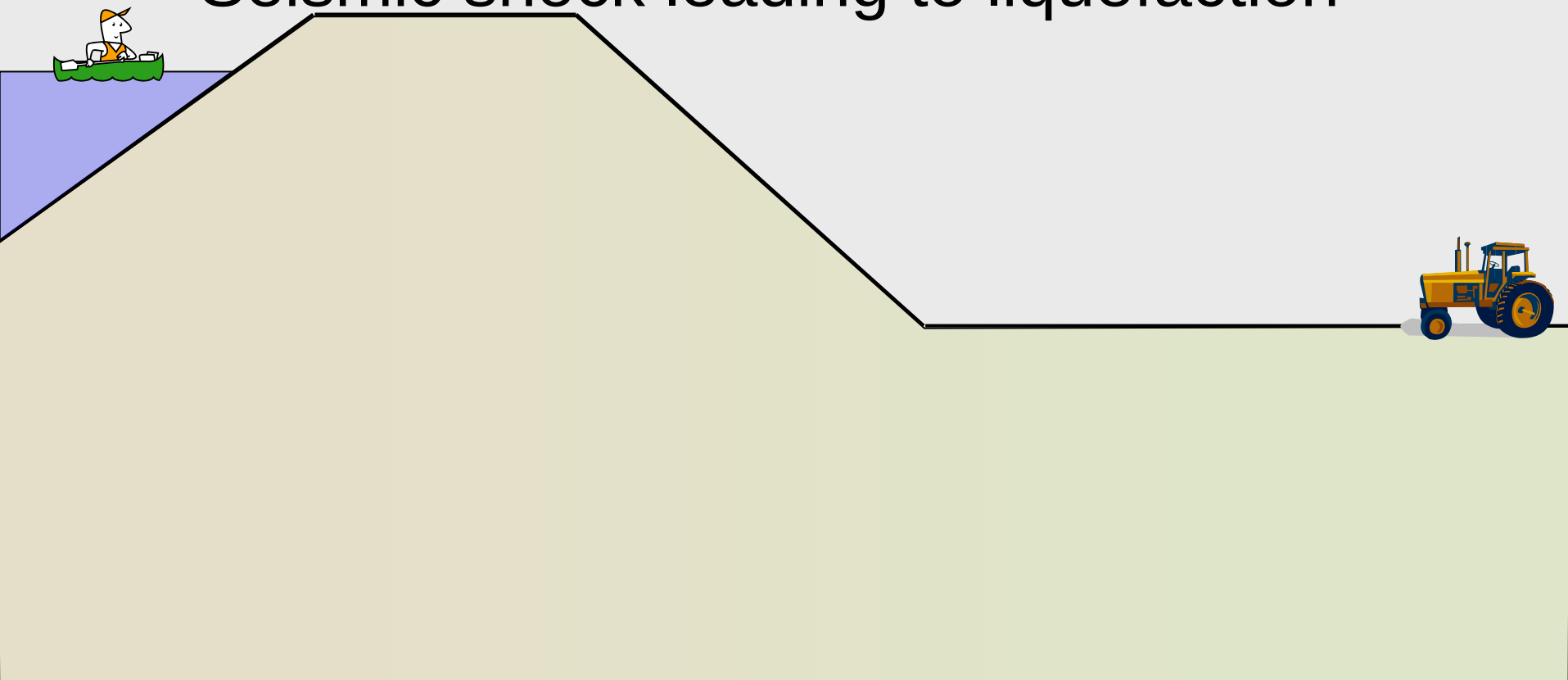
Levee Design

- Stability
- Seepage
- Overtopping

Slope failure

Usually:

- Disintegration of soil structure
- Increase in pore water pressure
- Seismic shock leading to liquefaction



Slope stability

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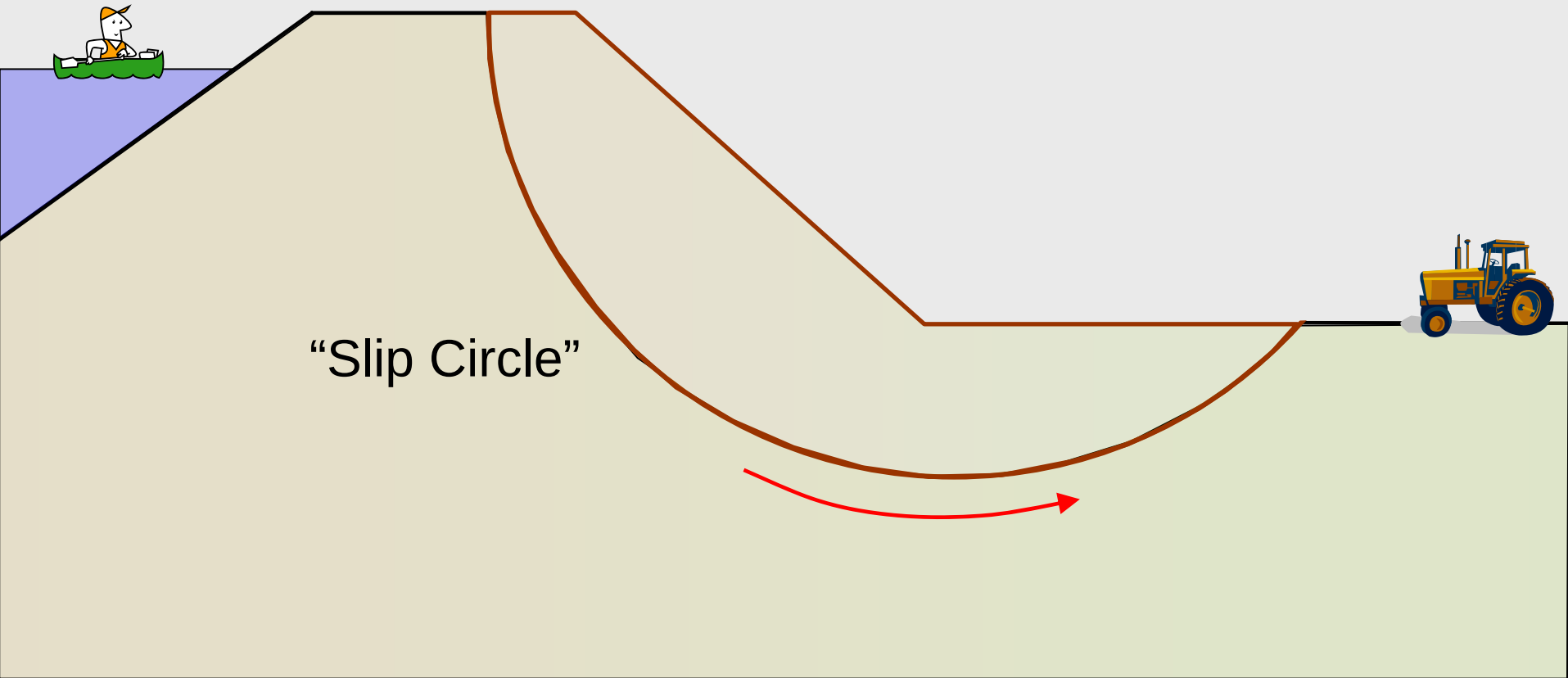

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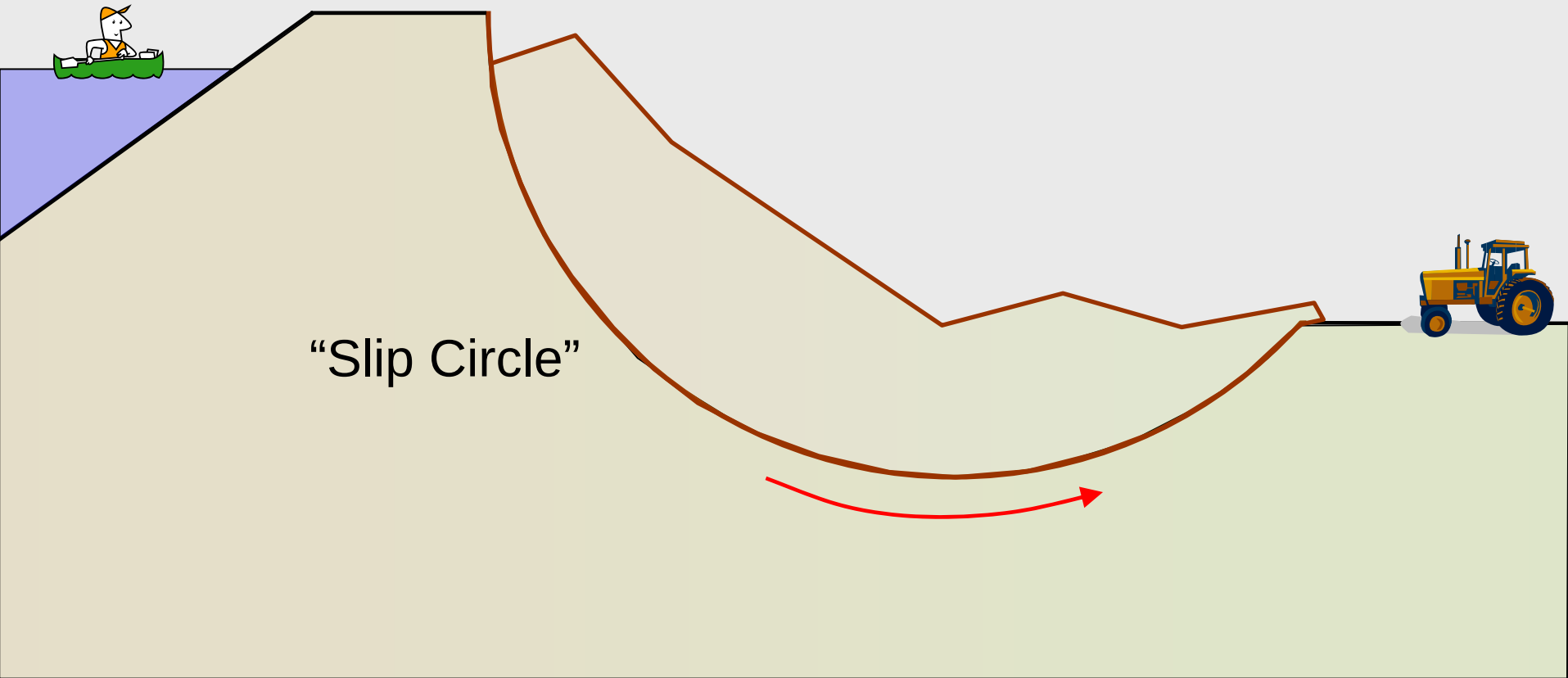

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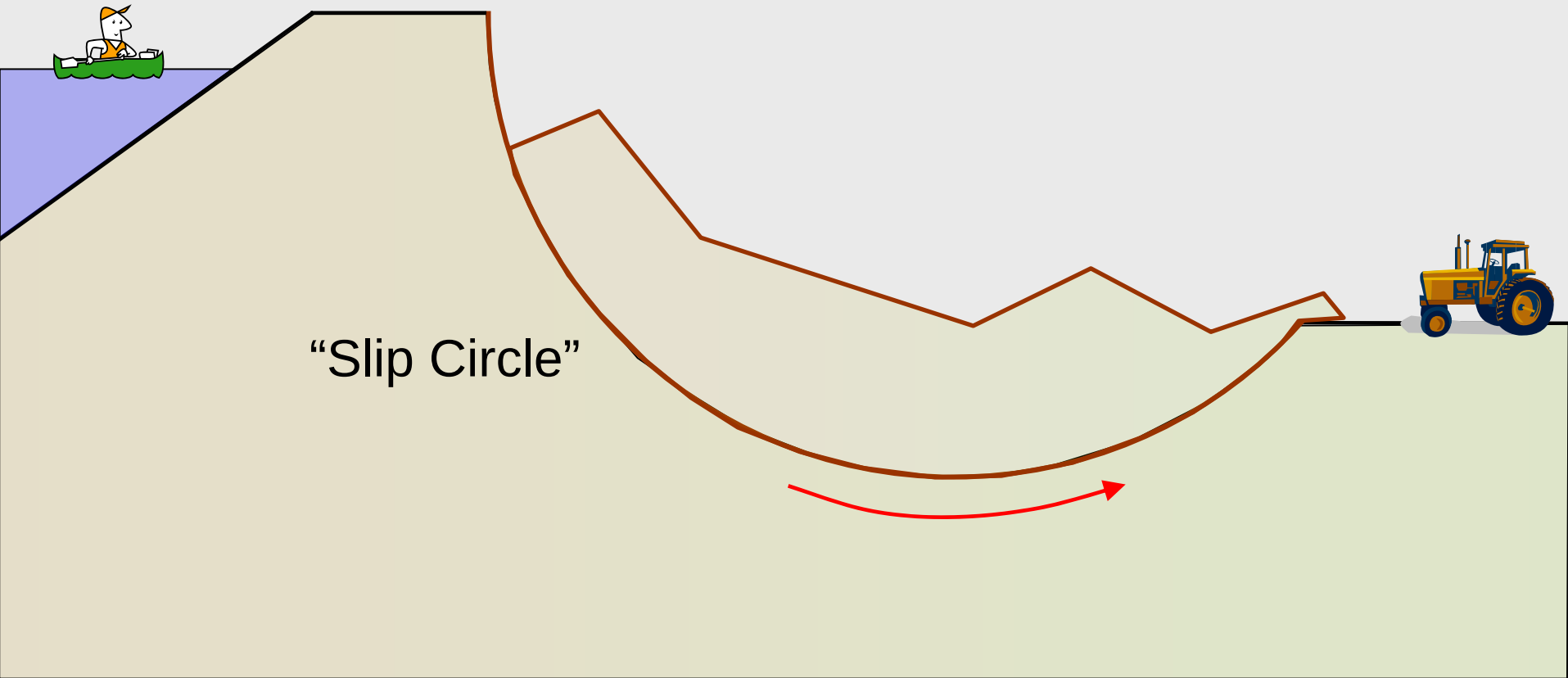

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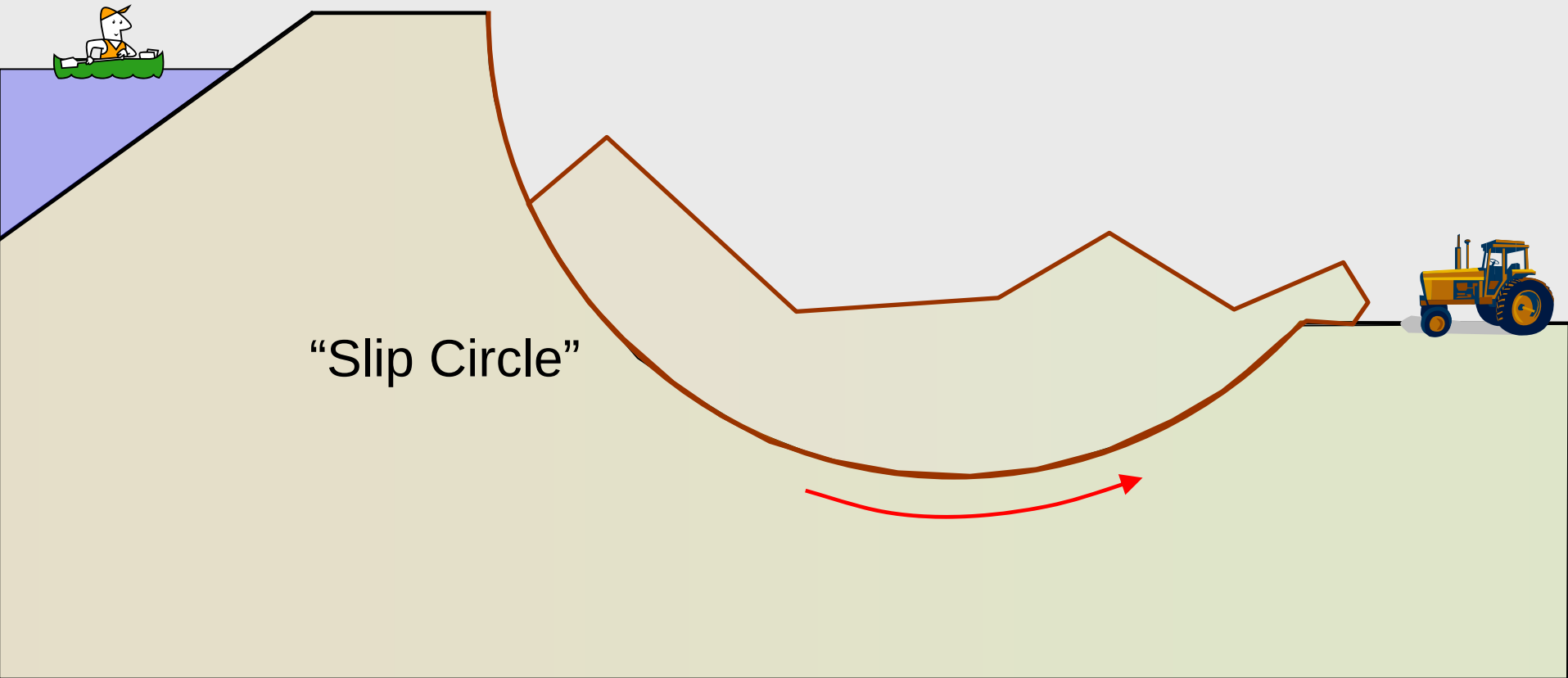

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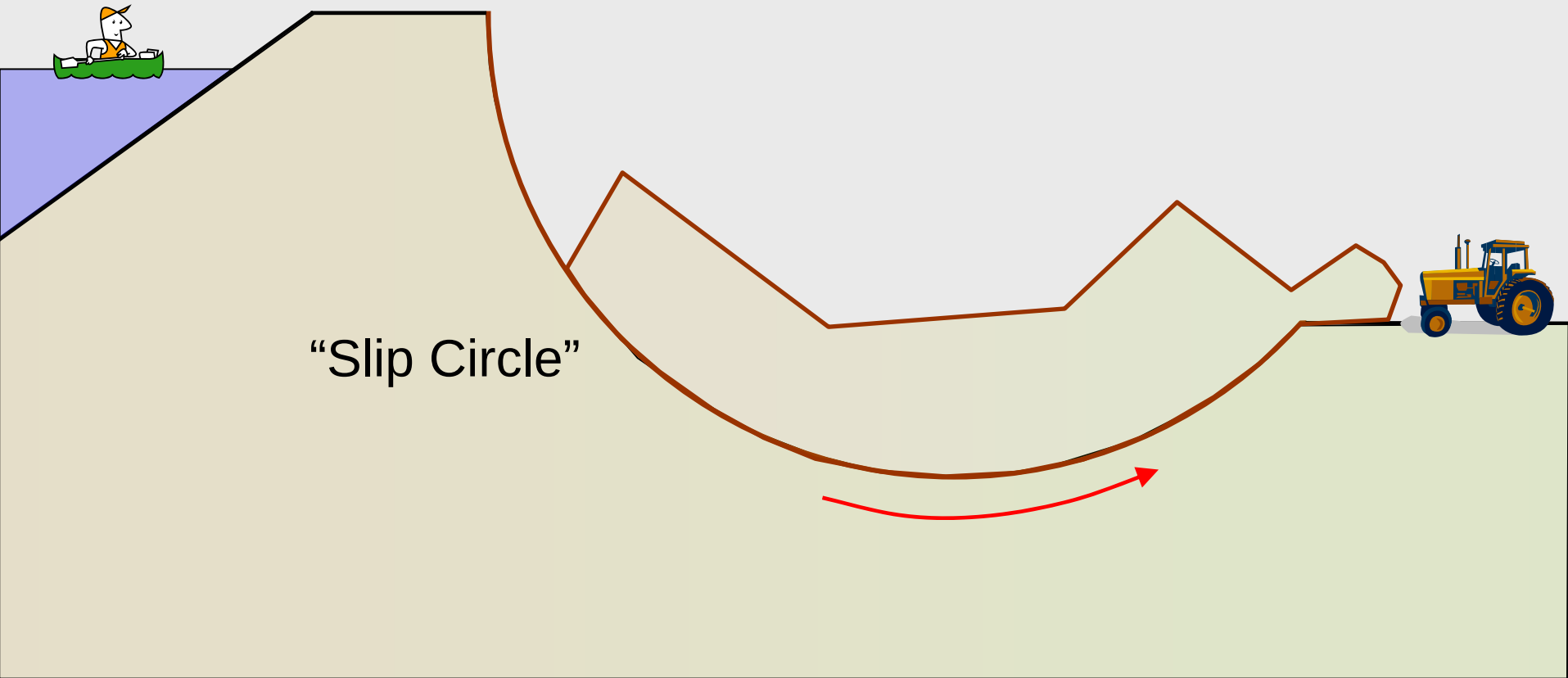

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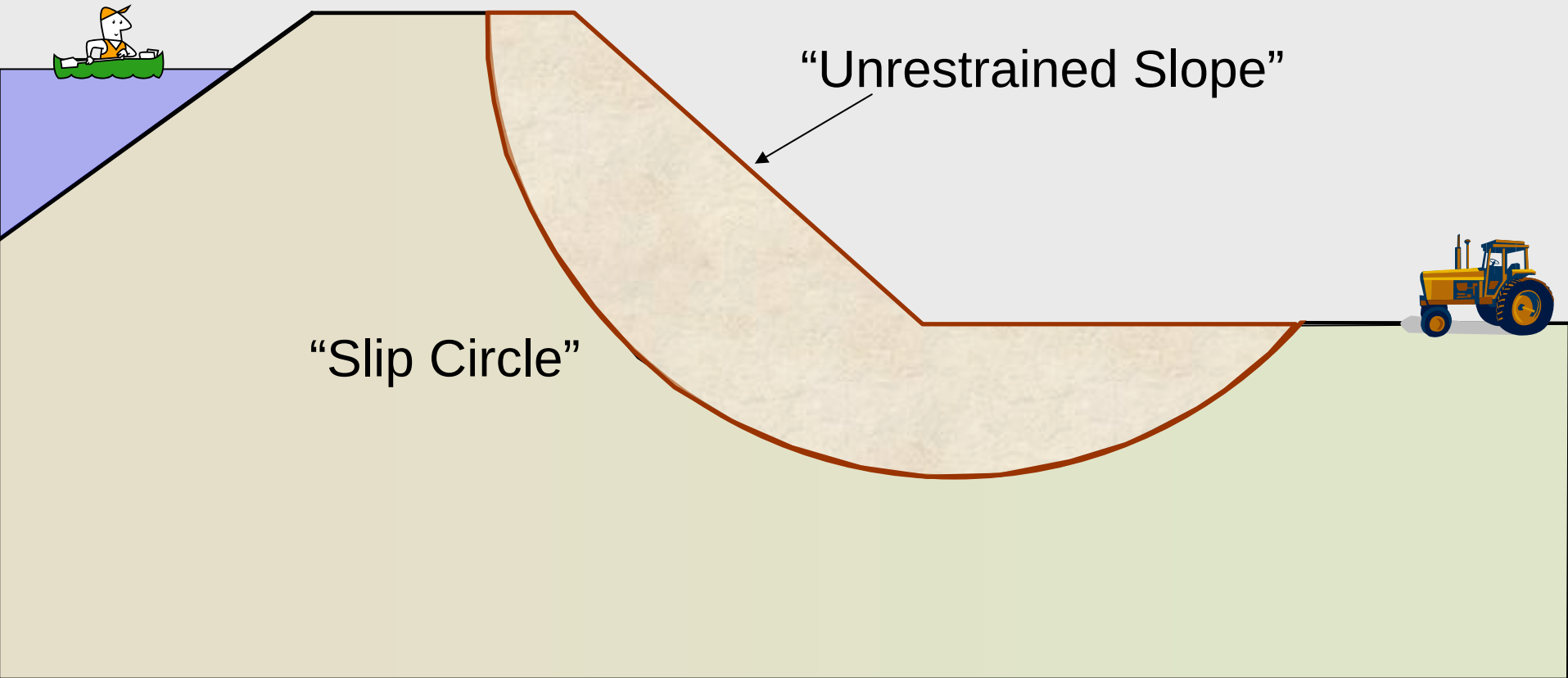
- Slope failure occurs if gravity force is greater than the shear strength of the soil.



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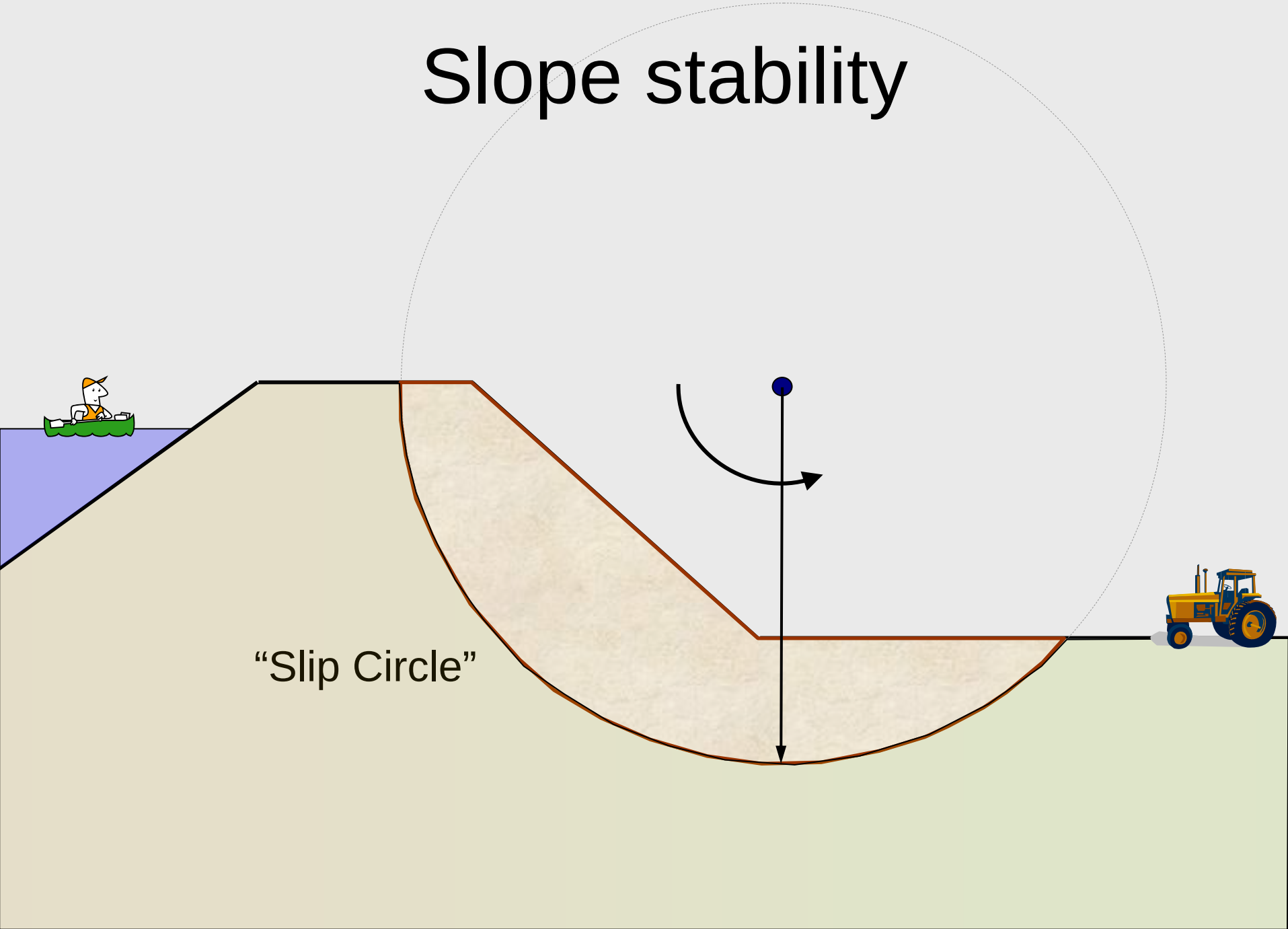

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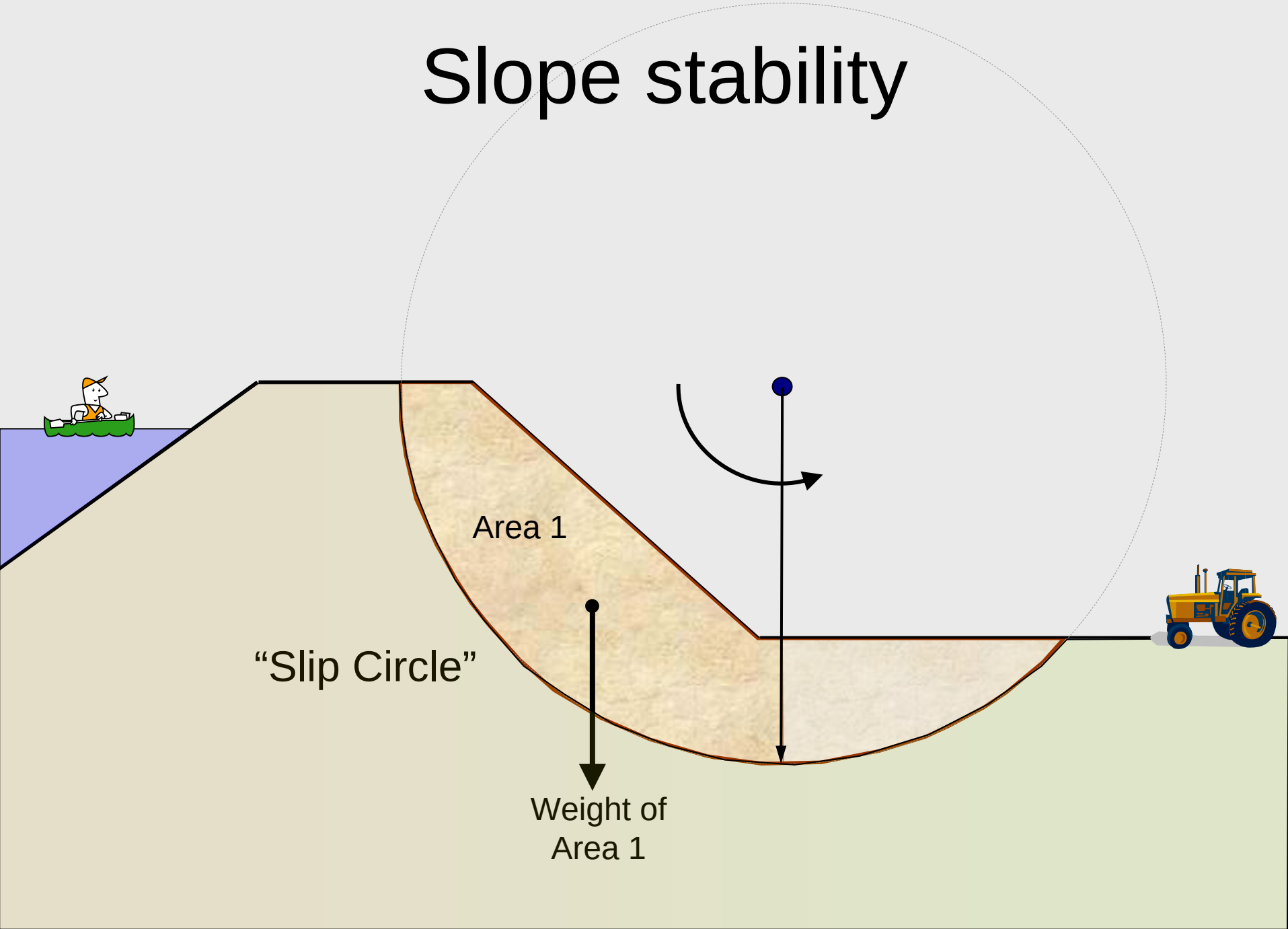

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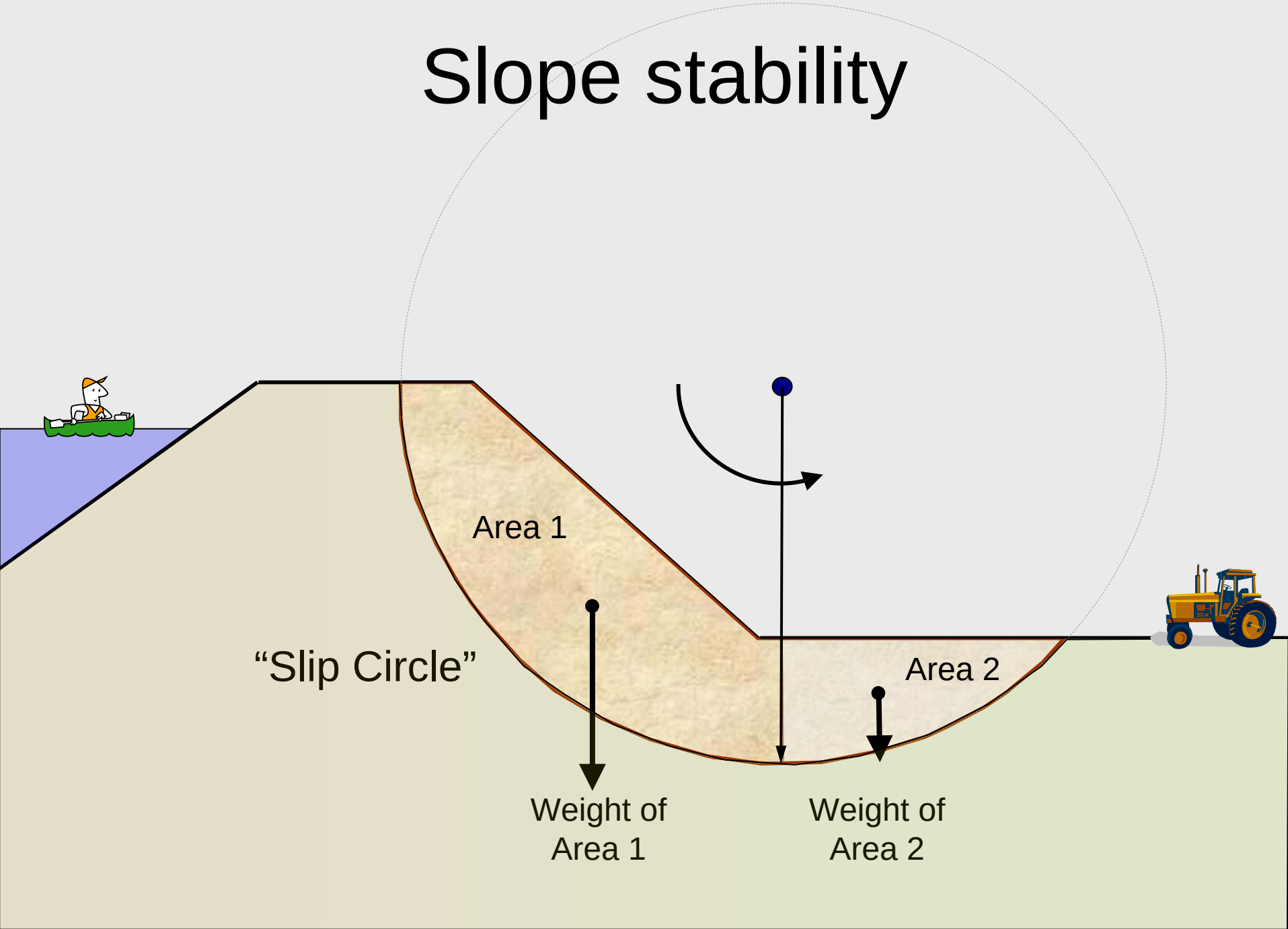

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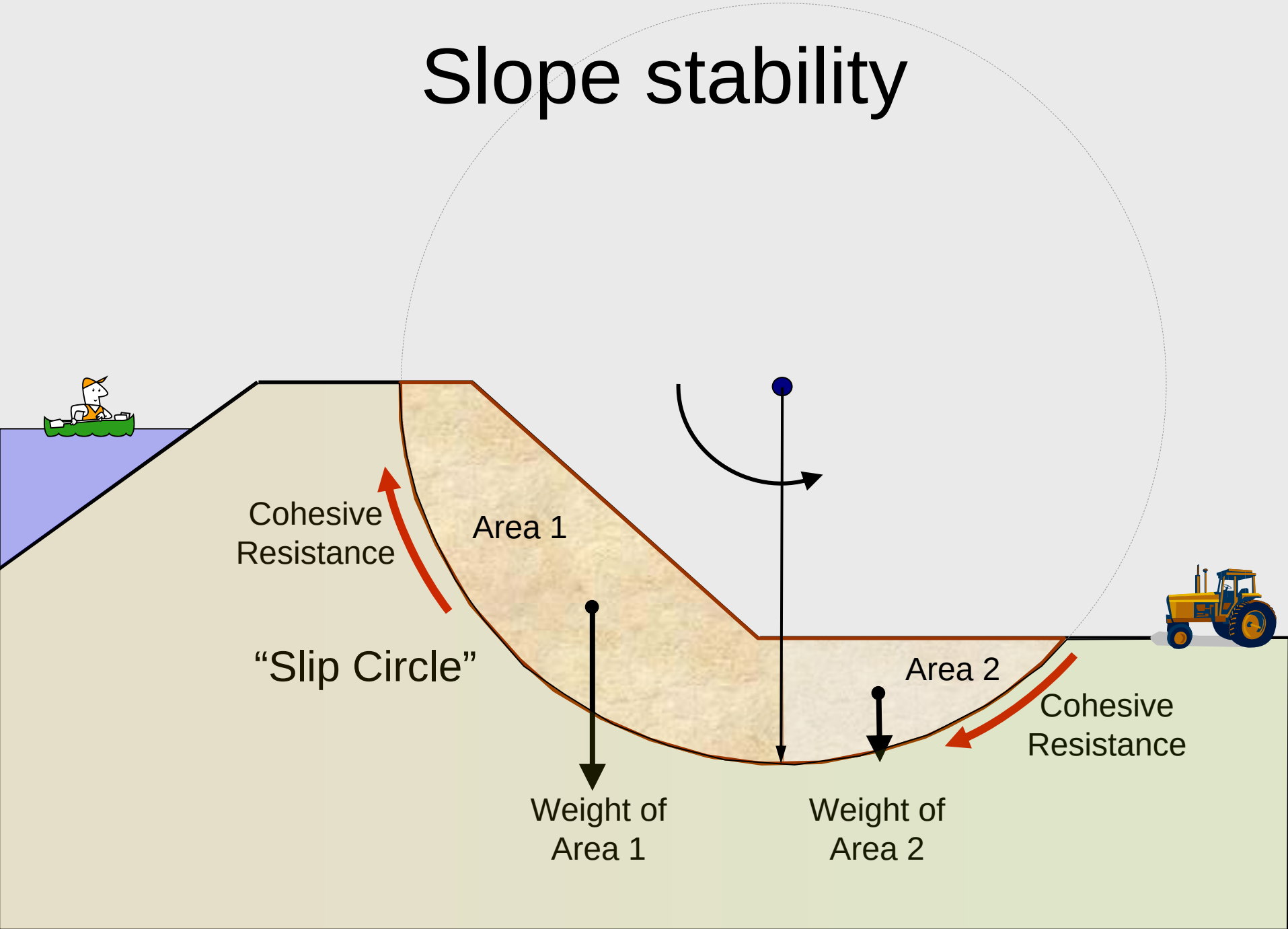

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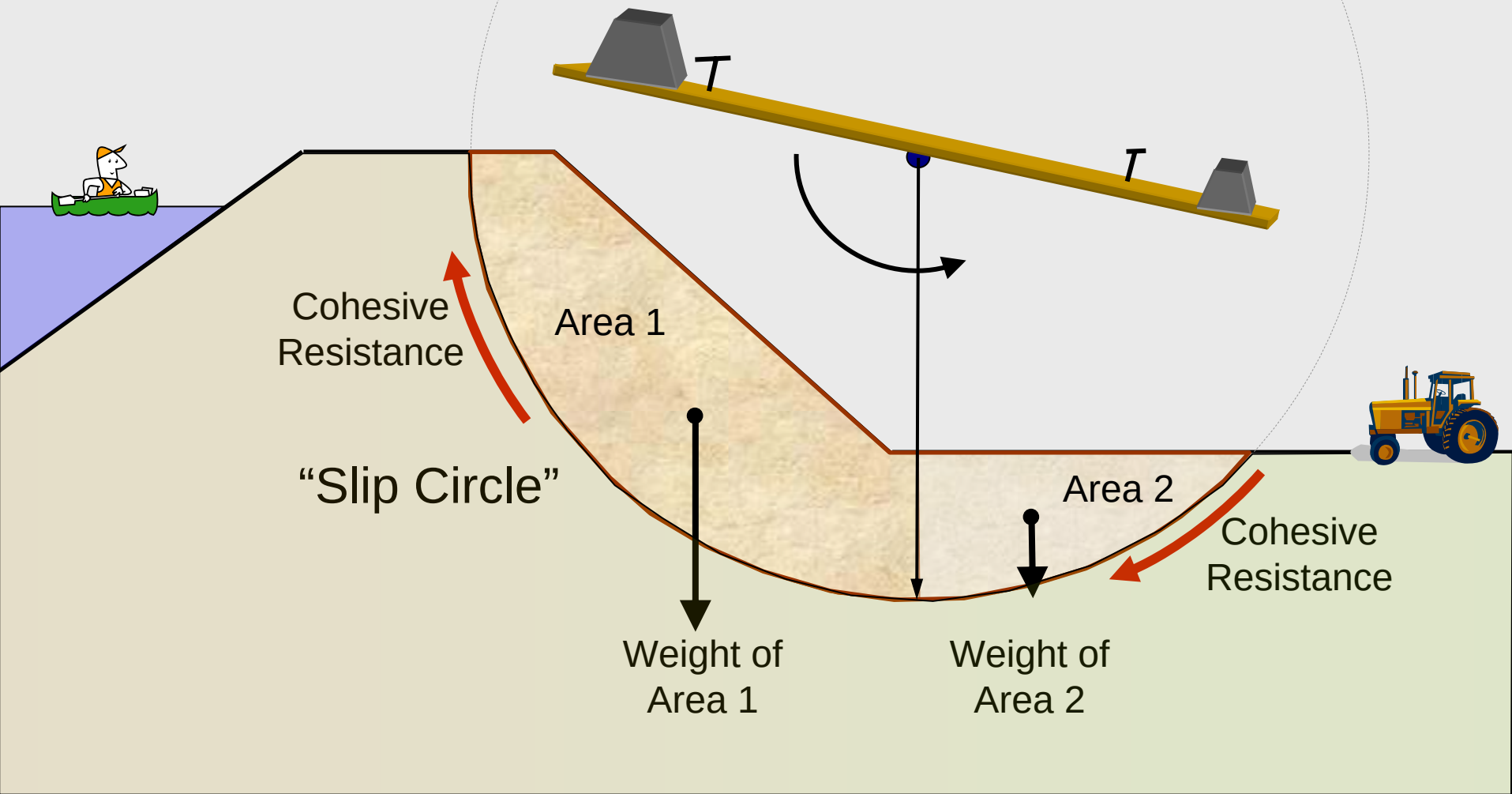

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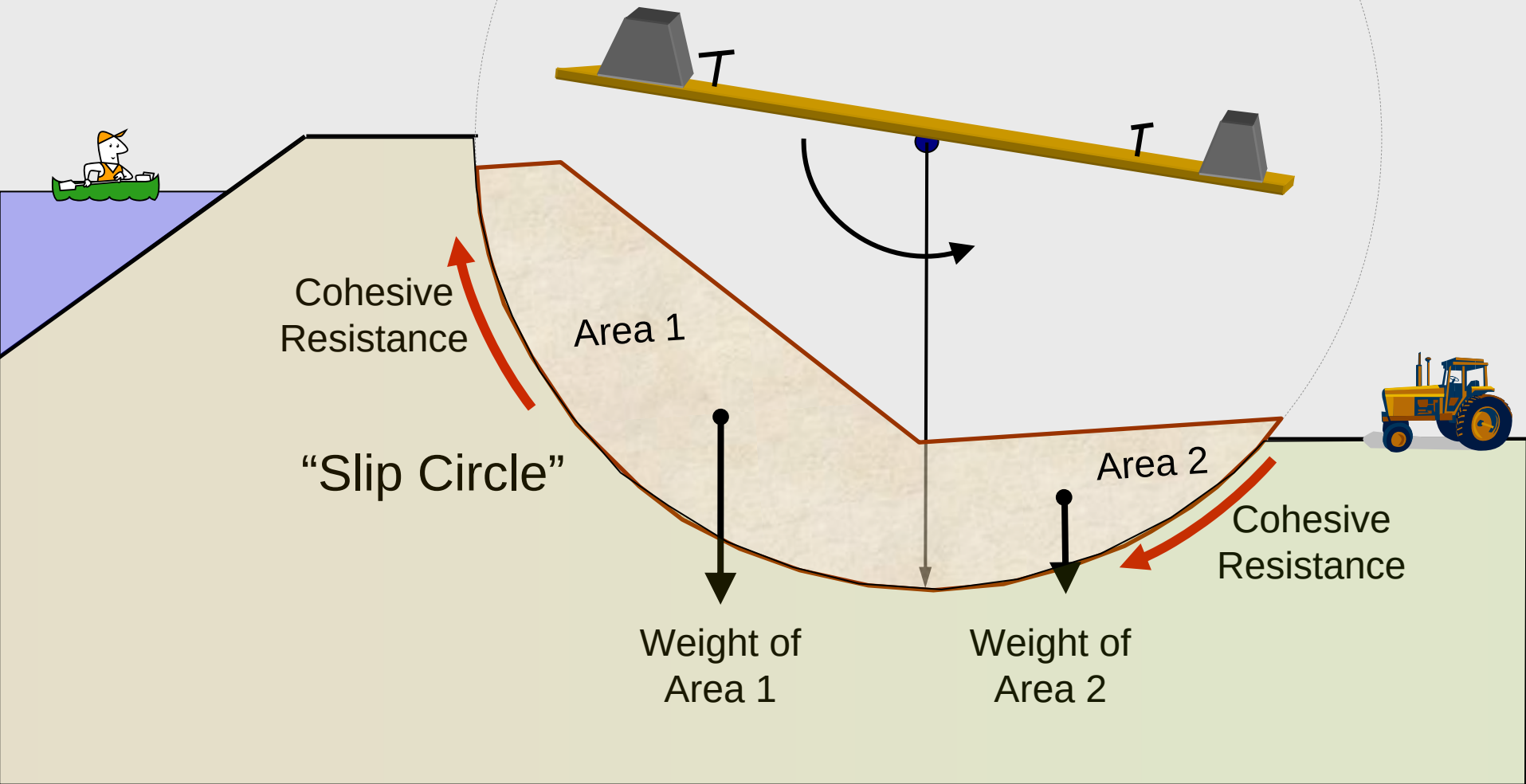

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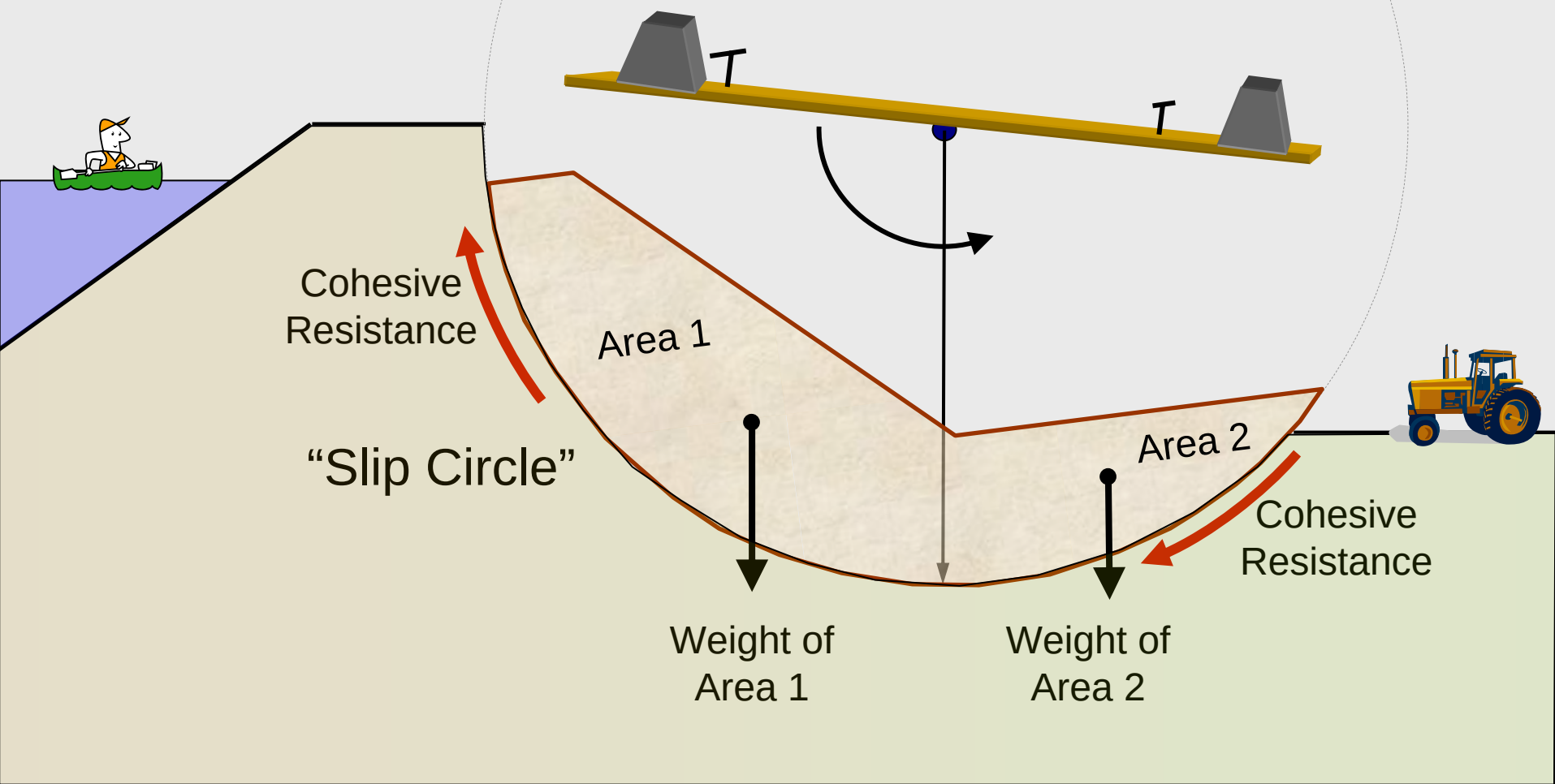

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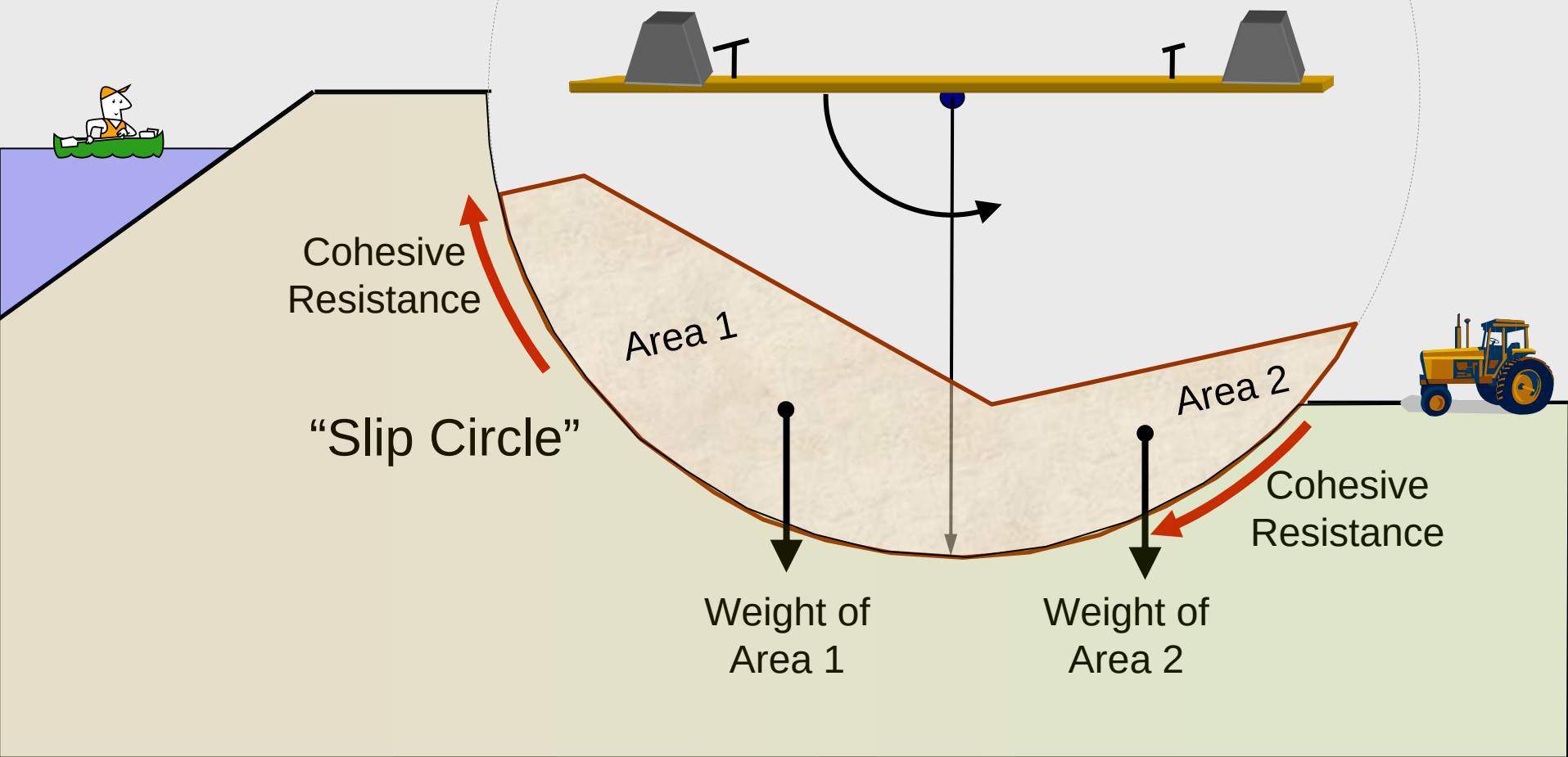
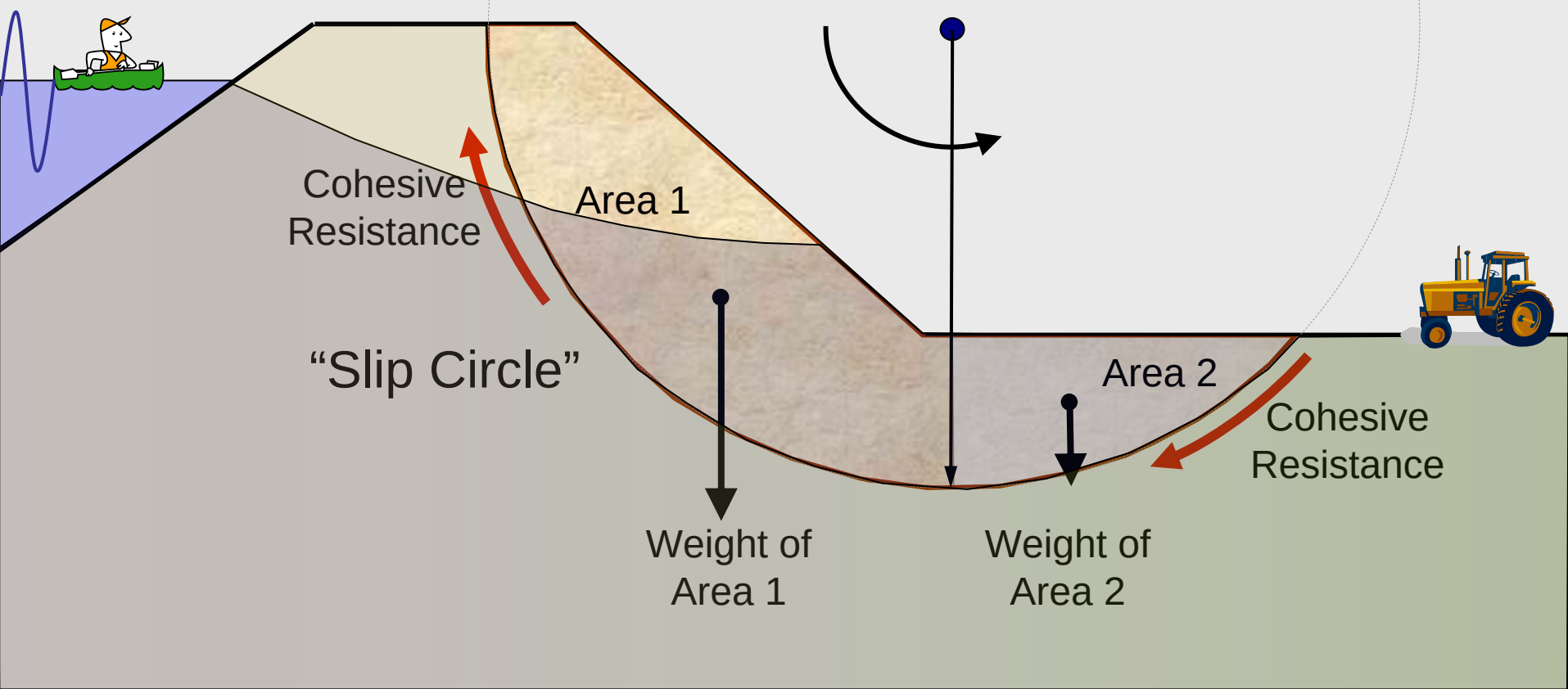


Seepage

Seepage reduces cohesive resistance



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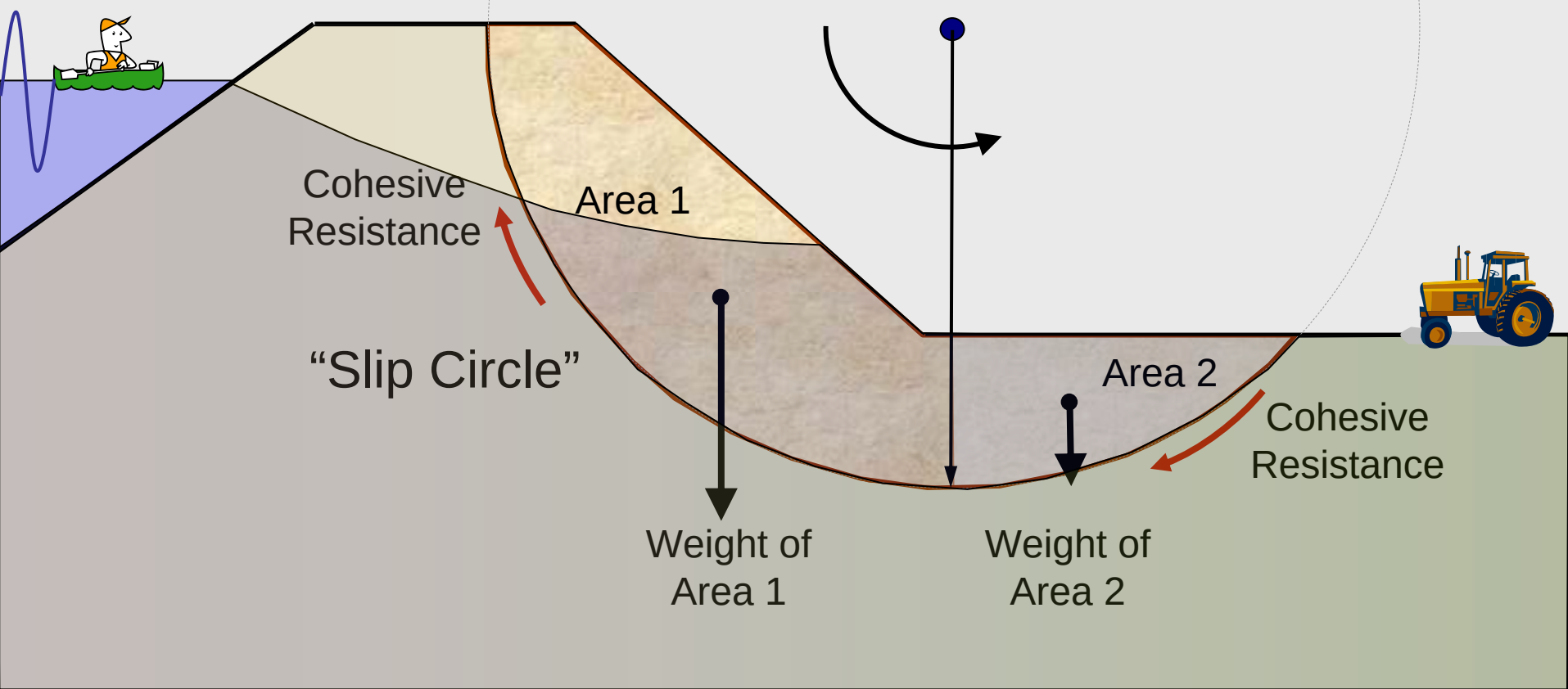

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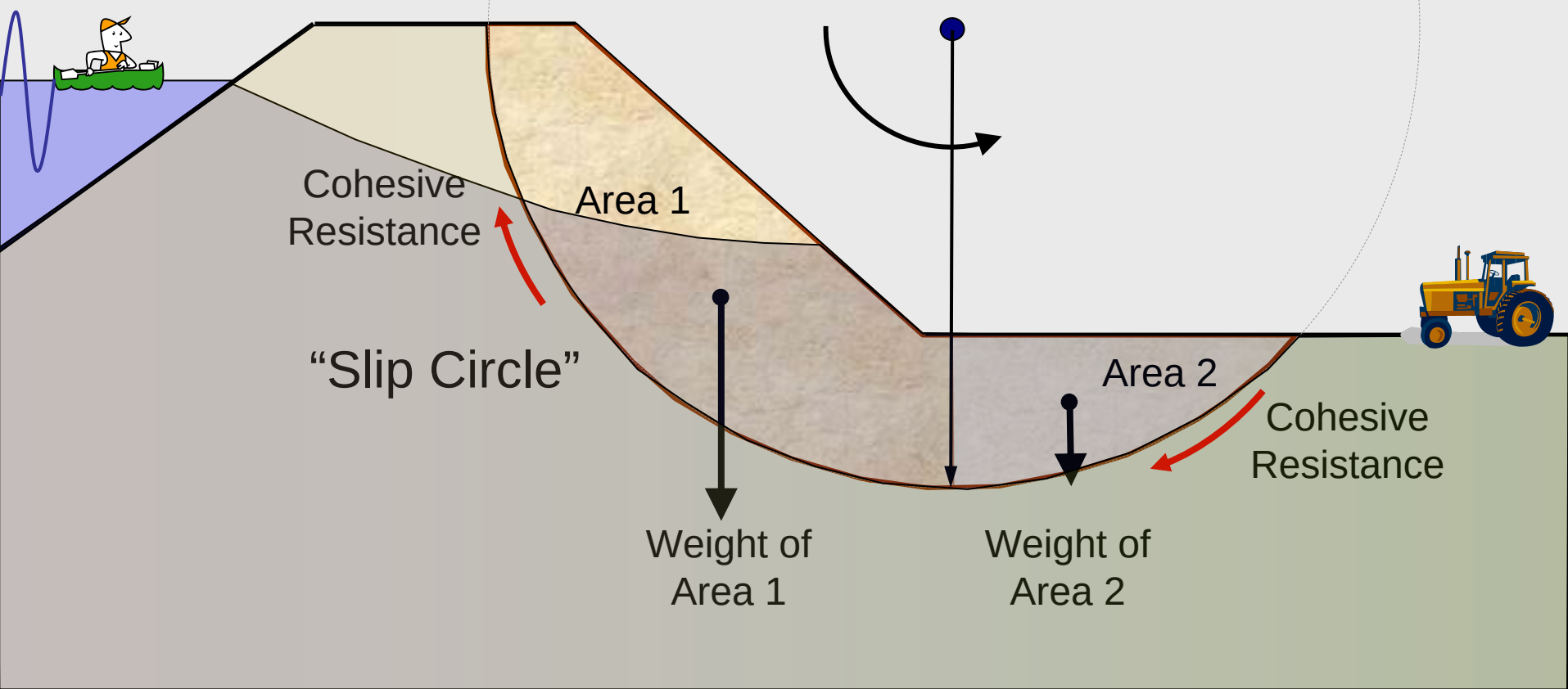

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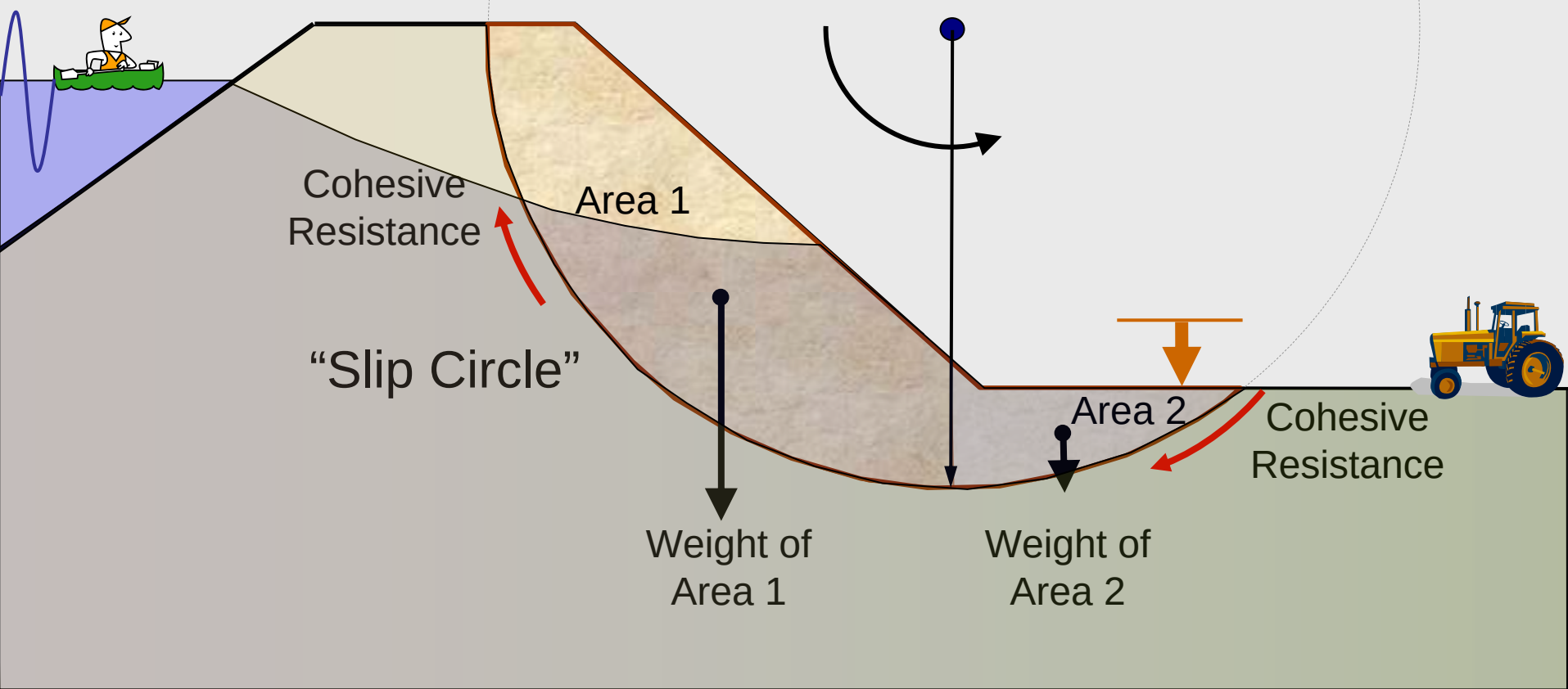

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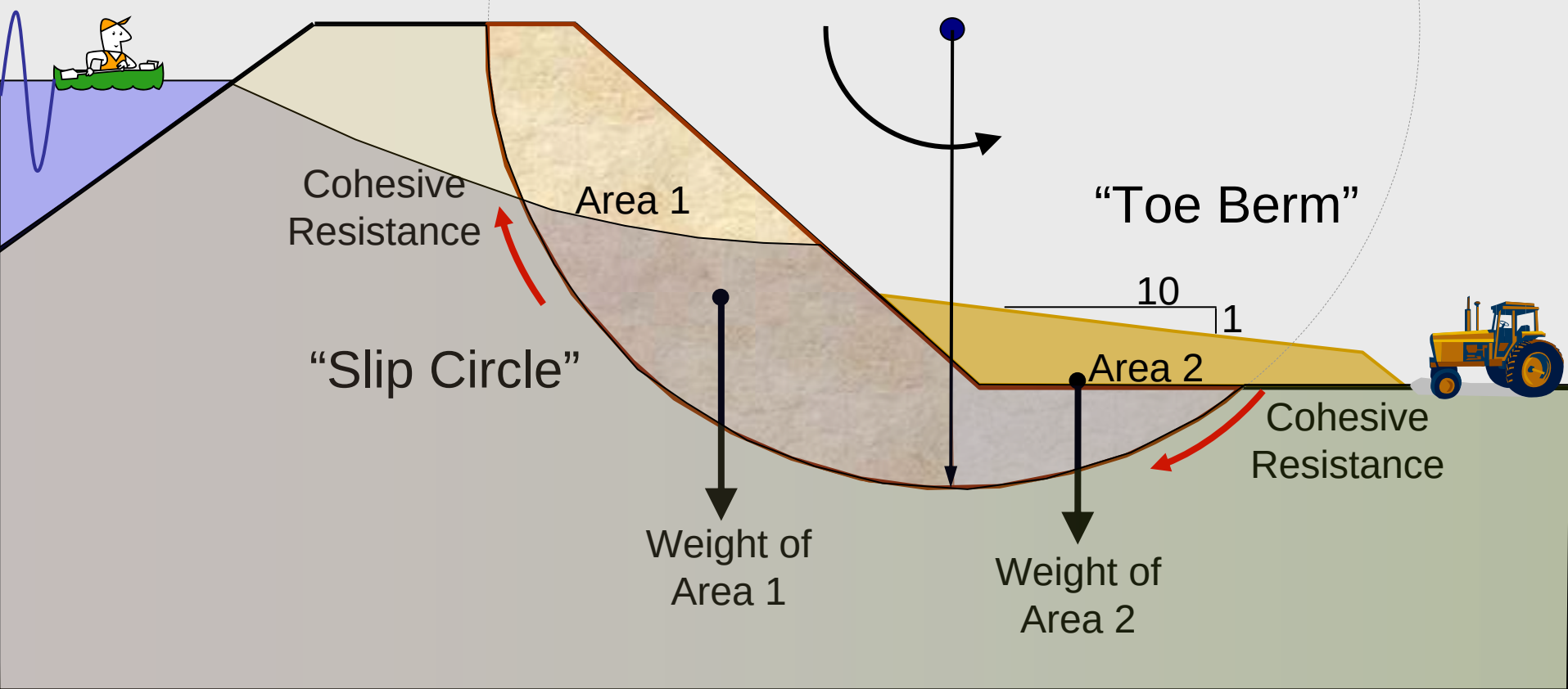
Rehabilitation Strategy:



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- Levee integrity is tied at the hip with land subsidence.

Thank you

- Randy Brown
- Steve Culberson
- Bruce Herbold
- Victor Pacheco
- Curt Schmutte
- Beth Schwehr
- Kevin Tillis